

December 1969

Brief 69-10807

NASA TECH BRIEF



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Investigation of the Development of Cracks in Solder Joints

The design of printed circuit board assemblies does not allow for the thermal stress produced on solder joints during operation in an environment with extreme temperature ranges. The relative difference in the expansion and contraction of the printed circuit boards and the components or component parts (including conformal coatings) used to fabricate the boards is reflected as a force in the component lead and causes stress and cracking in the soldered connection. A study was initiated to investigate the development of cracks in the solder joints and to recommend solutions that could be implemented into existing hardware assemblies with no further design changes. The study consisted of two phases. In the first phase, an analytical approach was used in which a mathematical model of existing printed circuit board component mounting techniques was analyzed and the forces on critical components were calculated. This approach permitted an insight into the basic problem, and thus led to ideas that could provide solutions to the problem. Mathematical models utilizing the proposed solutions were then analyzed to determine the theoretical validity of the solutions.

The second phase, an empirical investigation, was performed to determine the extent of damage caused by temperature cycling of the printed circuit boards under question and to determine the practical validity of the proposed solutions to the problem of the devel-

opment of cracked solder joints. During the empirical investigation, boards were fabricated and inspected in accordance with standard requirements. Several boards were fabricated to test both the normal procedures for mounting components and the proposed recommendations for mounting components that would rectify the problem. The results of the analytical and empirical investigations were compared to determine correlation of results achieved. The test data obtained in the empirical investigation confirmed that the use of a resilient pad greatly reduced the amount of force applied to a solder joint due to temperature changes; the use of the pad greatly reduces the number of cracked solder joints without redesign of the printed circuit boards.

Note:

Requests for further information may be directed to:
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Reference: B69-10807

Patent status:

No patent action is contemplated by NASA.

Source: R. L. Moore, and R. J. Vinson of
Sperry Rand Corporation
under contract to
Marshall Space Flight Center
(MFS-20444)

Category 01